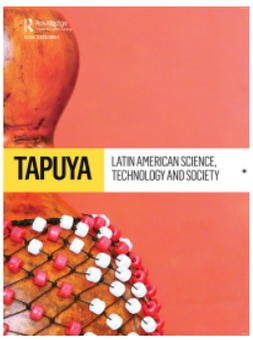
Agroecological innovation constructing socionatural order for social transformation: two case studies in Brazil



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Agroecological innovation constructing socionatural order for social transformation: two case studies in Brazil

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ABSTRACT

The Green Revolution exemplifies the capital-intensive modernization model of resource plunder and labor exploitation. This has provoked small-scale producers and civil society groups to counterpose an agroecology-based solidarity economy (EcoSol-agroecology), especially in Latin America. But their efforts encounter dominant models – of innovation, management, markets, nature, etc. – which limit alternatives. To clarify a transformative agenda, advocates have elaborated agroecological innovation through several complementary practices. Nature is framed as agri-biodiversity complementing socio-cultural diversity. Short food-supply chains (circuitos curtos) build consumer support for production methods enhancing producers' livelihoods, providing socio-economic equity and conserving natural resources. Through *diálogos de saberes*, i.e. knowledge exchange among farmers and with external experts, cultivation and water-management methods are designed or adapted as socio-environmental technologies. Capacities are built for collective self-management of those solidarity relationships. In such ways, agroecological innovation co-produces specific forms of nature, technoscientific knowledge and society; their practices construct a distinctive socionatural order. Such order arises through several instruments – making identities, institutions and discourses – as understood by STS co-production theory. Here this theory illuminates two Brazilian agroforestry initiatives whose cooperative practices seek to transform their own participants' lives and wider agri-food systems. By combining diverse sources, composite cultures deepen the social basis of territorial belonging.

KEYWORDS

STS co-production theory; agroecological innovation; solidarity economy; socio-environmental technologies; Brazil

PALAVRAS-CHAVE

Teoria "co-produção" nos estudos sociais de ciencia e tecnologia (ESCT); inovação agroecológica; economia solidária; tecnologias socioambientais; Brasil

PALABRAS CLAVE

Teoría de "coproducción" en los estudios sociales de la ciencia y la tecnología (ESCT); innovación agroecológica; economía solidaria; tecnologías socioambientales; Brasil

Inovação agroecológica construindo ordem socionatural para transformação social: dois estudos de caso brasileiros

RESUMO

A Revolução Verde exemplifica o modelo capitalista intensivo e modernizante para a pilhagem de recursos e a exploração de

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mão-de-obra. Isto provocou grupos de pequenos produtores e sociedade civil para pautar soberania alimentaria baseada em agroecologia, especialmente na América Latina. Não obstante, esses esforços encontram modelos dominantes – de inovação, gestão,mercados, natureza, etc. – que limitam as suas alternativas. Para esclarecer uma pauta transformativa, os promotores elaboraram inovação agroecológica através de várias práticas complementares. A natureza é enquadrada como agrobiodiversidade, complementando diversidade socio-cultural. Cadeias curtas de abastecimento de alimentos (circuitos curtos) constroem apoio dos consumidores para métodos que melhorem a qualidade de vida dos produtores de subsistência, proporcionando equidade socioeconômica e conservando recursos naturais. Através de diálogos de saberes, ou seja, intercâmbio de conhecimento entre agricultores e com especialistas externos, métodos de cultivo e gerenciamento da água são projetados ou adaptados como tecnologias socioambientais. As capacidades para autogestão coletiva dessas relações de solidariedade também são construídas. Assim, a inovação agroecológica coproduz formas específicas da natureza, do conhecimento técnico-científico e da sociedade; e tais práticas constroem uma ordem socionatural distinta. Tal ordem surge através de vários instrumentos – elaborando identidades, instituições e discursos – da mesma forma que se entende pela teoria de co-produção nos ESCT. Esta teoria está aqui ilustrada por duas iniciativas agroflorestais brasileiras cujas práticas cooperativas buscam transformar as vidas dos próprios participantes e o sistema agroalimentar mais amplo. Ao combinar diversas fontes, as culturas compostas aprofundam a base social de pertença territorial.

La innovación agroecológica construyendo el orden socionatural para la transformación social: dos estudios de caso brasileños

RESUMEN

La Revolución Verde ejemplifica el modelo modernista intensivo en capital que saquea los recursos y explota el trabajo. Esto provocó que grupos de pequeños productores y la sociedad civil desarrollaran una soberanía alimentaria basada en la agroecología, especialmente en América Latina. Sin embargo, sus esfuerzos se enfrentan a modelos dominantes – de innovación, gestión, mercados, naturaleza, etc. – que potencialmente limitan las alternativas. Para aclarar una agenda transformadora, los promotores desarrollaron la innovación agroecológica a través de diversas prácticas. A través de circuitos cortos alimentarios, una economía solidaria genera apoyo del consumidor para los métodos de producción, mejora los ingresos de los productores, proporciona equidad socioeconómica y conserva los recursos naturales. A través de los diálogos de saberes, es decir, el intercambio de conocimiento entre agricultores y con expertos externos, los métodos de cultivo se diseñan o adaptan como tecnologías socioambientales. La naturaleza se forma como agrobiodiversidad, complementando la diversidad sociocultural. Las capacidades colectivas se crean para la autogestión o la gestión compartida de múltiples actores de la cadena agroalimentaria y más allá. De esta manera, la innovación

agroecológica coproduce formas específicas de la naturaleza, el conocimiento tecnocientífico y la sociedad, prefigurando así un orden socio-natural distintivo. Tal orden surge a través de diversos instrumentos – como la creación de identidades, instituciones y discursos – tal como se entiende en la teoría de la "coproducción" en los Estudios Sociales de la Ciencia y la Tecnología (ESCT). Aquí esta teoría ilumina dos iniciativas agroforestales brasileñas cuyas prácticas cooperativas buscan transformar las vidas de sus propios participantes y los sistemas agroalimentarios más amplios. Al combinar diversas fuentes, las culturas compuestas profundizan la base social de la pertenencia territorial.

1. Introduction

In Latin America, the dominant agri-development model has been called "the Green Revolution" by advocates and critics alike. Through this model, enterprises have been industrializing agriculture by linking capital-intensive equipment, chemical-intensive inputs and land appropriation. Large land tracts have been increasingly turned into agri-industrial sites for global export commodities, mainly for animal feed, ultra-processed food or cotton fabrics. Promoted by the agribusiness political lobby, this model has been expanded by most governments through support measures over several decades.

Meanwhile, critics have documented several harmful consequences, especially land grabs, ecosystem destruction, malnutrition, gender inequalities, socio-economic injustice and global pandemics (e.g. Hidalgo 2020; Wallace et al. 2020). The Green Revolution exemplifies a modernization model of resource plunder, labor exploitation and dispossession. Given those multiple harms, many small-scale producers and civil society groups have counterposed a solidarity economy based on agroecology extending agri-food traditions. Agroecological innovation has enabled low-income small-scale producers to improve their livelihoods while conserving natural resources, especially in Latin America.

Research questions for this paper: How does agroecological innovation devise alternatives to the dominant modernization model? How do such alternatives depend on specific contexts, means and capacities?

To answer those questions, this paper analyzes two case studies in Brazil. Given its rival agri-food development models, the country has sharp conflicts, especially over land tenure, resource usage, and public policies. Located in São Paulo state, our two cases have different socio-geographical contexts, representative of more widespread ones. In particular:

Assentamento Mário Lago: The landless movement has established numerous settlements and demanded collective land tenure under Brazil's Agrarian Reform program. Even after gaining such tenure, settlements have faced further challenges – recuperating land from its previous harmful usage, creating a congenial social basis for sustainable livelihoods, establishing amenities (such as health services, education and cultural activities) that would attract entire families to remain, and gaining external support for such improvements. Pursuing all those aims, Assentamento Mário Lago initiated agroforestry development and devised collective marketing of the products.

Fórum de Comunidades Tradicionais (FCT): In many coastal areas, diverse traditional communities have gained livelihoods from resource-light artisanal activities for centuries. But they lack security of land tenure or resource access, which have been jeopardized by several changes – conservation areas, real estate development and heavy tourism. To counter these threats, in one coastal area the Fórum de Comunidades Tradicionais (FCT) has built unity among the three traditional communities: indigenous, quilombolas and caiçaras (see further below). The FCT has been promoted through collective initiatives such as natural resource protection, agroforestry development and Community-Based Tourism.

In their different contexts, both cases exemplify an agroecology-based solidarity economy. Each initiative has promoted its agroforestry development as a showcase for environmentally sustainable and socially equitable arrangements. Each has helped other agroforestry initiatives to learn from its practices.

To answer the research questions above, this article starts with two general surveys: Firstly, agroecological innovation as an alternative development model linking solidarity economy and socio-environmental technologies. Secondly, STS co-production theory on the rival models; see summary in Table 1. Then those perspectives are applied to each case study in turn; see summary in Table 2. The conclusion returns to the research questions.

Table 1. Rival agri-food models as co-production.

	Agri-industrial modernization	EcoSol-agroecology
Co-producing three elements (Jasanoff 2004)		
Nature	Binary forms: monocultures (good Nature) are threatened by bad wild Nature and so need agrochemical protection.	Agro-biodiversity complements socio-ethno-diversity. Biodiverse multi-cropping offers protection from pests.
Knowledge		
Source	Diffusionist model: experts design technology packages to enhance monoculture yields in standard commodities.	Knowledge-exchange process generating and spreading social technologies (Dagnino, Brandão, and Novaes 2004, 2020). Artisanal methods at all stages.
Products	Grain for animal feed (esp. export) and ultra-processed food or cotton.	Mainly fresh fruit and vegetables, some with light processing.
Social order		
Supply chains	Competition in distant markets via profit-driven middlemen	*Circuitos curtos* extending traditions of mutual aid, reciprocity, *mutirões, etc.*
Gender in/equalities	Men prevail, more easily accessing loans to buy technology packages and await payments for the harvest.	Women form collectives to overcome socio-economic inequalities and to valorize their contribution.
Instruments		
Identities	Techno-modernization aiming to maximize yields.	Mutual aid (*mutirões)* extended from traditional communities
Institutions		
Economic form	Competitive enterprise	Cooperative form of production or sales.
State support roles	Agri-industry lobby (*Bancada Ruralista*) has gained many support measures, especially large-scale infrastructure for irrigation and export markets.	EcoSol-agroecology networks have demanded and used support measures, especially loans, capacity-building and infrastructure for *circuitos curtos*.
Discourses	Overcoming backwardness of the countryside via modernization.	Transforming the dominant system, e.g. via *Bem Viver* as a cosmo-vision.

Table 2. Two Brazilian case studies as co-production.

Initiative **Co-producing three elements** (Jasanoff 2004)	**Assentamento Mário Lago**, Ribeirão Preto (periphery)	**Fórum de Comunidades Tradicionais** (FCT), Costa Verde, Litoral Norte
Nature: *Sistemas Agroflorestais* (SAFs)	SAFs regenerate ecosystems which had been degraded, provide biodiversity protection for crops, and generate abundance for settlers.	SAFs' agro-biodiversity complements ethno-cultural diversity of the three communities.
Knowledge		
Cultivation methods & roles	Cultivators learn techniques from external experts in the field. Cooperatives' work teams take turns in doing tasks, building skills for collective self-management.	Traditional cultivation knowledges enter in a dialogue with scientific knowledge through action research: ~ *trocas de saberes* = knowledge exchange.
Socio-environmental technologies spread capacities	Techniques link reforestation, nature conservation, food production and thus livelihoods. Also water capture, storage and treatment.	Techniques for conserving forests, harvesting & processing fruit, etc. Also for managing water, remediating polluted beaches, etc.
Social order	Agroforestry facilitates social cohesion and spreads methods to other settlements.	Inter-community cooperation to conserve natural resources and resist territorial threats.
Three instruments		
Collective identities		
Environmental guardians protecting natural resources.	Through *Sistemas Agroflorestais Agroecológicos (SAFAs),* collective skills link better income, health, environmental protection, socio-economic inclusion, etc.	*Sistemas Agroflorestais* (SAFs) symbolize inter-community unity for resource conservation: *Juçara* conservation and gastronomy provides a new cultural identity.
Training for self-management roles and more equal relationships	*Plano de Desenvolvimento Sustentável* (*PDS*) recharges the aquifer on which Ribeirão Preto depends. Urban sales provide dignity to settlers as forester-food producers.	OTSS facilitates theme-based nuclei with and among the three communities to build collective capacities for shared management.
Institutions		
State-funded projects build collective expertise	*Projeto Agroflorestar* helped to build collective capacities, later extended through producer cooperatives. MST staff gained expertise to write grant proposals.	*Projeto Juçara* gained state support for conserving forests, harvesting juçara fruit and processing for short food chains. OTSS-FCT partners write grant proposals.
Organização de Controle Social (OCS) for organic certification	*OCS* provides organic certification through a *Sistema Participativo de Garantia* (SPG).	*OCS* provides organic certification through a SPG with multi-actor support.
Short food-supply chains build consumer support for solidarity economy	School meals provided regular income. CSA box scheme has increased regular income and motivated broader participation.	Agroforestry products are commercialized collectively. *TBC* promotes community cultures, nature conservation and food products.
Discourses	"Families cooperate and enjoy abundance." Occupy, Produce, Resist.	*Justiça Socioambiental. Preservar é Resistir* (To conserve is to resist)

2. Agroecological innovation as alternative models

The Green Revolution model aims to "modernise the countryside to bring it out of backwardness," as sarcastically described by critics (Caporal and Costabeber 2004, 6). Such critiques have advocated and motivated support measures to realize the greater potential of traditional cultivation methods. This potential lies in knowledge-intensive agroecological methods using locally available resources, towards an agriculture which is socio-

environmentally and economically sustainable (Caporal and Costabeber 2004, 79). But these efforts encounter obstacles from pervasive dominant models – of innovation, management, markets, nature, etc. – which therefore must be overcome.

Agroecology was originally defined as "the scientific basis for an alternative agriculture" (Altieri 1983). Agroecology depends on knowledge-based internal inputs: agroecosystems mimick ecological processes by recycling nutrients and conserving biodiversity, within and beyond production units (Wezel and Soldat 2009). Later such traditional practices were grounded in social agrarian agendas and social movements resisting capitalist modernization, especially the techno-diffusionist model of the Green Revolution (Altieri 2002).

This resistance role has been taken up by small-scale producers seeking a structural transformation of the countryside, markets and society (Altieri and Nichols 2008; Altieri and Toledo 2011; Rosset 2003; Martinéz-Torres and Rosset 2014; De Schutter, 2010). In the 1990s "agroecology as a scientific discipline went through a strong change, moving beyond the field or agroecosystems scales towards a larger focus on the whole food system, defined as a global network of food production, distribution and consumption" (Wezel et al. 2009, 3). To transform that system, agroecology has been framed politically as "ecological management of natural resources through forms of collective social action … which contribute to deal with the social and ecological crisis and thus confront neoliberalism and economic globalisation" (Sevilla Guzmán 2006, 9). Without a transformational strategy, agroecology would be relegated to marginal niches or disparate techniques for "greening" agri-industrial systems (Levidow 2018).

To strengthen small-scale farms, agroecology agendas have sought to enhance their natural resource base, productivity and livelihoods. Agroecological practices have been "restoring local self-reliance, conserving and regenerating natural resource agrobiodiversity, producing healthy foods with low [external] inputs, and empowering peasant organizations" (Altieri and Toledo 2011). "For peasants and family farmers and their movements, agroecology helps build autonomy from unfavorable markets and restore degraded soils, and social processes and movements help bring these alternatives to scale" (Rosset and Martínez-Torres 2012, 17). This perspective has facilitated links among farmer organizations, consumer-citizen groups and social movements.

Around the turn of the century Brazil's main political force struggling for land reform, the Movimento dos Trabalhadores Rurais Sem Terra (MST), sought alternatives to the Green Revolution model on its settlements. Some began to experiment with agroecological practices (Borsatto and do Carmo 2013; da Silva 2011). Peasant-civil society networks demanded supportive public policies such as infrastructure, subsidy and capacity-building. Such measures were gained especially during the 2003–2016 governments led by the Partido dos Trabalhadores (FAO 2017). Some local authorities have complemented the support roles of national bodies.

The rest of this section elaborates on the wider EcoSol-agroecology agendas, before demonstrating their relevance to the two case studies.

2.1. Solidarity economy via short food-supply chains

In Latin America, the Economia Social y Solidaria (EcoSol for short) expresses interdependencies across economic activities (dos Santos and Carneiro 2008; Schüttz and Gaiger

2006; Singer and Souza 2000). Self-management facilitates human development for its participants (Singer 2002, 21). Cooperative relationships enhance capacities and income, especially through short supply chains bringing producers closer to consumers.

Organizations previously promoting either EcoSol or agroecology eventually converged towards integrating them, in a form which can be denoted as EcoSol-agroecology (FBES 2011; Schmitt 2020, 39). EcoSol has been elaborated to promote and expand Brazil's agroecological systems (FAO 2017; Neumann and Bergamasco 2016). Such initiatives create relationships of trust and rural-urban solidarity, strengthening the social fabric for agroecological production methods and distribution networks (Vivas 2017).

For capacity-building, the Programa de Aquisição de Alimentos (PAA) has brought together small-scale family farmers to learn cooperative skills for collective marketing. A major opportunity has been public procurement programs, especially the Programa Nacional de Alimentação Escolar (PNAE), which has purchased food for school meals. Under PNAE public institutions pay a 30% premium price for organic and agroecological products, making these methods economically more viable for producers. The program aims to promote the biophysical development, learning and training in healthy food habits of students, especially to fulfill their nutritional needs during the school term (Brasil 2009). Local procurement programs favor such products from small family farms (CIAPO 2013).

Such programs have helped family farms to strengthen their self-esteem, improve their agroecological methods and diversify their production (Grisa 2009). From this starting point, agroecological initiatives have also established short food-supply chains directly to consumers on the basis that their purchases support cooperative work organization and environmentally sustainable practices. Small-scale producers bypass conventional markets, rather than seek a futile competition on the same terms.

In order to move towards an agri-food solidarity economy, since the 1990s several civil society organizations had been promoting organic certification through a Sistema Participativo de Garantia (SPG) under producers' control, rather than an expensive third-party *auditoria* systems (Schmitt et al. 2017a, 85; da Costa et al. 2017, 290; Schwab and Collado 2017, 2). The PT government eventually accommodated such proposals through a new model, an Organização de Controle Social (OCS): each cooperative has "a relationship of organization, commitment and trust amongst the participants"; this system aims at "stimulating a direct relationship between the producer and final consumer" (MAPA 2007, 2008). Alongside the lower cost, peasants prefer this system because it is less bureaucratic, according to an NGO which has promoted this alternative (interview, Instituto Giramundo Mutuando, September 4, 2017).

In each case, small-scale producers cooperatively build the OCS-SPG system with their own local norms. Their collective capacities have been built through various non-governmental agencies, e.g. the Assessoria e Serviços a Projetos em Agricultura Alternativa (AS-PTA), and the Rede de Agroecologia Ecovida. Organic certification helps small-scale farmers gain advantageous institutional markets through state procurement programs.

2.2. Diálogos de saberes *for* tecnologias sociais

Agroecological systems have generated new hybrid knowledges, integrating traditional with scientific knowledge to use locally available natural resources. Such techniques have been improved through *diálogos de saberes*, i.e. knowledge exchange among

farmers and with external experts (Delgado and Rist 2016; Martinéz-Torres and Rosset 2014). Some agroforestry systems apply syntropic techniques, which imitate "natural succession" processes enhancing symbiotic relationships amongst diverse organisms. Such methods help to recover soil fertility and regenerate ecosystems, as a basis and incentive for agroforestry or permaculture (Campos, 2016; dos Santos Rebello, 2018).

The Brazilian state established technical assistance measures to support agroecological practices. Since 2004 the Programa Nacional de Assistência Técnica e Extensão Rural (Pronater ou PNATER) has promoted farm-level experiments of technologies more appropriate for smallholders, including agroecological methods (Schmitt et al. 2017a, 88–89). Yet, the diffusionist approach often persisted, continuing a technological dependence. This "translates into cultural dependence, immobilising local autonomous innovation capacities, thus diminishing the manoeuvre-room of rural families and communities for self-determination through a permanent implementation of their technical-economic strategies" (ANA 2007, 7).

When small-scale farmers received subsidies or loans under the Programa Mais Alimentos, they bought machinery and equipment, stimulating them to cultivate larger areas with more external inputs (Mussoi 2011, 182). Agroecology is often adopted as a simple input-substitute for technology packages of the Green Revolution (Mussoi 2011, 256). When providing support measures to small-scale farmers, often the state research agency EMBRAPA has promoted a portfolio of agroecology "technologies," thus perpetuating the diffusionist approach (Petersen, Mussoi, and Soglio 2013, 110, 112).

To overcome such limitations, agroecology practitioners have linked knowledge-exchange processes with the concept "social technology." The latter denotes a design and use promoting social aims such as collective capabilities, inclusion and socio-economic equity (Dagnino 2009; Fressoli and Dias 2014; ITS 2004; Serafim, de Jesus, and Faria 2013; Pires and Novaes 2016, 116). Artisanal skills are adapted in new ways, rather than replaced by technology (Dagnino 2009). Through social technology, production methods are cheaply developed, consolidated, appropriated by the producers, as a basis to replicate them elsewhere.

In 2003, Brazil's advocates established a Rede de Tecnologia Social (RTS), which gained support from the state bank: "Social technologies are products, techniques or methods which are replicable, developed in interaction with the community and which represent effective solutions for social transformation" (FBB n.d.). The concept was taken up by the state's EcoSol agency: "Sustainable development valorizes the potentials and endogenous production systems based on social technologies appropriate to the context, whose aim favours preservation of people and communities" (CNES 2015, 16). Their development has been promoted by support measures and awards (e.g. CRATS 2016). The concept was taken up by agroecology practitioners and support measures; Brazil's national agroecology plan made a commitment to social technologies through the Programa Ecoforte (CIAPO/Planapo 2013; Schmitt 2020, 41–44).

3. Co-production theory: analytical approach and research methods

All the above processes arise in specific practices, which can be analyzed through co-production theory. Here "co-production of nature, technoscientific knowledge and society" is theorized as complementary elements of an overall socionatural order. Technoscience

can be understood as socio-technical hybrid constructs, ordering society in particular ways, while attributing that order to inherent "natural" characteristics: hence a socionatural order (Jasanoff 2004, 21). In contexts where innovation generates conflicts, social disorder or anxieties about them, there are disputes over epistemic boundaries, e.g. between what is un/changeable or natural/social.

3.1. Instruments of co-production

Interactive co-production helps to analyze how these boundaries undergo challenges amidst competing epistemologies. Various practices make, stabilize or destabilize those boundaries (Jasanoff 2004, 18–19, 30). Co-production theory can illuminate how technoscientific expertise helps solve a problem of socio-political order (Jasanoff 2004, 34). In the co-production process, the socionatural order is constructed through several instruments, especially identities, institutions and discourses. As theorized by Jasanoff (2004, 38–41):

Making identities: Identity is a potential resource with which people restore sense out of disorder. "Redefining identity is a way of putting things back into familiar places." Such identities include characteristics such as European, professional, intelligent, etc. Collective identities are contested or renegotiated in working out technoscientific orders.

Making institutions: Institutionalized ways of knowing are reproduced in new contexts; they also serve as sites for testing or reaffirming a political culture. Tacit models of human agency underlie discourses of public institutions. According to a model of market capitalism, for example, the human subject is able to form autonomous preferences, make rational choices, and act freely upon the choices so made; any exceptions are interpreted as a market failure, rather than a problem with the model. Sometimes new institutions emerge to provide normative understandings for new characterizations of nature.

Making discourses: Languages are produced or modified in ways which promote tacit models of nature, society, culture or humanity. They may enable reasoned action by defining the boundary between promising and fearsome aspects of a technology – e.g. between "un/natural" and "un/safe" characteristics of nature and technology. Strategic discourses appropriate current discourses and adapt them for new needs (Jasanoff 2004, 38–41).

3.2. Three elements being co-produced

In STS literature, co-production theory has generally focused on technoscientific controversies. Here it will be adapted for agroecology initiatives creating alternatives to dominant models and handling tensions with them. From this perspective, Brazil's EcoSol-agroecology agenda has some general features of socionatural order, antagonistic to the dominant agri-food system (see Table 1). Yet the alternative model exists only in context-specific forms that coherently link natural resources, knowledge and social order (Table 2). This section elaborates those three categories with wider literature, especially from Latin America. In particular:

3.2.1. Nature

In agri-industrial systems, nature is split into two forms. As a raw material, Nature is domesticated and improved for genetically uniform seeds for monocultures, hence good Nature. These face environmental threats from a wild, diverse, bad Nature, which must be controlled by agrichemicals in order to maximize yield. This binary has served to construct the Green Revolution as a socionatural order, making it seem as obvious progress.

By contrast, agroecology cultivates agro-biodiversity as a crucial resource to protect agri-production from environmental stresses and to produce diverse foodstuffs, especially from crops' original landraces. Multi-cropping protects cultivation from pests and disease. This complements the socio-ethno diversity of rural communities, especially indigenous groups and women. Through farmers' markets, women have valorized biodiverse products of marginal agri-subsystems such as their *quintal* (back garden).

This post-capitalist approach aims "to valorise humanity's ethnic-cultural diversity and promote different forms of managing biodiversity production in harmony with nature" (Leff 2001, 50). As a cosmo-vision familiar in Latin America, *Bem Viver* means "a harmonious life respecting Mother Nature," originating from indigenous Andean languages. The concept has been promoted by EcoSol networks (FBES 2012; citing Bolivia 2008).

With its reference to *Terra Madre, Bem Viver* echoes early resistance to capitalist development. The eighteenth-century British utilitarians idealized the market as the natural regulator, complementing the entrepreneurs' natural right to maximize the land's productive utility and their natural liberty to trade goods including such land. Nature was newly understood through metaphors of machine and market, while turning land into calculable capital and raw materials. Resisting land enclosures, peasants counterposed traditional organic metaphors of land as a basis for natural justice, whereby the yeomanry lived from its own labor on the commons (Williams 1980, 79).

3.2.2. Knowledge

In agri-industrial systems, experts devise agronomic techniques for "transfer" to farmers, e.g. genetically uniform seeds and agrichemicals; together these comprise "technology packages" of the techno-diffusionist model. By contrast, agroecological networks facilitate *diálogos de saberes*, i.e. knowledge exchange among farmers and with external experts to improve artisanal methods (Martinéz-Torres and Rosset 2014; Petersen 2020, 21, 37). Farmers build collective knowledge of agroecosystems, i.e. ecological relationships within and around agri-systems, especially the ways they can help protect crops and increase productivity. Products are mainly fresh fruits and vegetables, sometimes with light processing for various benefits, e.g. aesthetic, nutritional or longevity.

In EcoSol networks more generally, artisanal skills are adapted for new needs and contexts. Relevant techniques have been understood as social technologies. They have been designed for socio-economic equity and easy reproducibility, thus facilitating a solidarity economy (Dagnino, Brandão, and Novaes 2004). The concept "social technology" extended STS perspectives on how the dominant technoscientific knowledge reinforces capitalist social relations and therefore warrants a democratic redesign favoring alternative interests and values (Feenberg 2002). Having popularized the concept "social technology" for more than a decade, its originator recently substituted the concept with "solidarity technoscience." This better expresses his original meaning, namely, collective

producers achieving a change in a product whose material gain is appropriated according to a collective decision (Dagnino 2020, 18).

The above concepts have been further elaborated as "socio-environmental technology." This has been defined along lines of sustainable development, namely: techniques facilitating practices that are environmentally sound, socially just, economically viable, culturally acceptable, and easily replicable. Such innovations aim to use locally available resources, exchange knowledge, use appropriate didactic tools, create knowledge-multipliers and spread environmental responsibility (IAM 2016).

3.2.3. Social order

The dominant agri-industrial system structures production for a competitive advantage in distant anonymous markets. Whenever small-scale producers attempt to imitate or accommodate this model, men more easily access loans to buy technology packages and await payments for the harvest. But they face structural disadvantages in competing on the same terms; they lose much of the value-added to profit-driven middlemen. Some have undergone long-term debt and have abandoned farming.

By contrast, EcoSol-agroecology networks develop short food supply chains, called *circuitos curtos* (short circuits). Prevalent forms include: public procurement for school meals, Community-Supported Agriculture (CSA) and farmers' markets (*Feiras do Agricultor*). Agroecological producers have gained collective capacities with support networks for a shared management of these solidarity markets. Their income supports a different social order, e.g. a cooperative work organization, environmentally sustainable practices and means to overcome gender inequalities. A familiar slogan is, "There is no agroecology without feminism" (ANA 2018).

In EcoSol-agroecology initiatives, social relations extend *mutirão,* a widespread rural culture of mutual aid and reciprocity. Originally a Tupi Guarani term, *motyrõ* signifies a joint or cooperative effort (Navarro 2005). Nowadays it denotes joint work in which all contribute and take turns, whereby the results benefit all participants. *Mutirão* facilitates closer inter-personal contact, knowledge exchange, congenial work activity and sometimes love relationships (Diegues 2005, 296–297). In the informal economies of EcoSol, *mutirão* constructs composite cultures combining diverse sources and so deepens the social basis of belonging (Zaoual 2010).

3.3. Case-study methods

As shown above, EcoSol-agroecology initiatives have some general patterns, but these exist only in context-specific forms, which warrant detailed analysis. This paper compares two agroforestry initiatives in São Paulo state (see again the Introduction and Table 2 summary). Facilitating our preparation, each case already had numerous academic studies, journalistic reports and promotional films available on websites. Moreover, the Brazilian co-authors had prior links with the initiatives, as a basis for them to host a long one-day visit.

Before visiting each initiative, the research team collected information on its origins, aims, experiences, self-organization and external relations, thus building on prior research of the Brazilian co-authors. Each site visit had a semi-structured, in-depth interview with key organizers, followed by a tour, continuously conversing with our hosts and other participants. We started with general questions such as: "What future are you creating? How is this more

sustainable and inclusive?," including environmental, economic and social aspects. Interviewees' initial comments prompted more specific questions on all the above issues.

Their interview comments provided a basis for follow-up through more internet searches for documents on the two cases and their wider context, thus helping to clarify or extend our analysis. Our follow-up ends in 2018–2019, before Covid-19 restrictions stimulated major changes (which would warrant a new paper). Many literature citations and all interview material come from Portuguese-language sources; they have been translated here by the authors.

The two Tables correlate STS co-production theory with practitioners' activities and concepts. Of course, each aspect may have relevance to several elements and instruments of co-production. So our judgements had some flexibility about where to put each aspect in the Tables; we preferentially filled all the cells in order to indicate rich inter-linkages of practices and meanings. To summarize the rival agri-food models, Table 1 draws on documentary sources. To summarize our case studies as diverse alternatives, Table 2 indirectly draws on our interviews.

4. Assentamento Mário Lago

Since the 1980s the rural landless movement, Movimento dos Trabalhadores Rurais Sem Terra (MST), has been carrying out numerous land occupations. Many settlers were peasants previously displaced by agribusiness who migrated to plantations as laborers or to cities. Some settlements eventually gained land tenure from Brazil's Reforma Agrária through a Federal agency, the Instituto Nacional de Colonização e Reforma Agrária (INCRA). They initially imitated Green Revolution methods, but some sought agroecological alternatives. The MST slogan, *Ocupar, resistir e produzir*, originated in the 1980s as a response to severe repression (Cassin and Nalli 2016, 361); later it referred also to settlements collectively marketing agroecological products (MST 2018).

That transition is exemplified by Assentamento Mário Lago. In 2003, it started as a joint action by MST with a social movement in the nearby city, Ribeirão Preto (Cassin and Nalli 2016). After long judicial proceedings against the agribusiness owner, in 2008 INCRA officially expropriated the land for the settlement and granted collective tenure.

4.1. Regenerating the land, building collective capacities

In the Ribeirão Preto region, agri-industry had colonized the most fertile land and natural resources. As a major center of capital-intensive agriculture, it produces fertilizers as well as commodity crops (sugar, soya, maize, cotton), which are mainly exported. Strong support has come from the municipal authority, branding the region as Brazil's Capital of Agribusiness (ABAGRP 2013).

That adverse context was turned into an opportunity by the settlement. Beforehand its site had been a chemical-intensive sugarcane plantation which deforested the area, degraded the soil, and undermined the Guarani Aquifer on which the nearby city depends. Those environmental problems motivated a Federal agency to reach an agreement for a Plano de Desenvolvimento Sustentável (PDS): the settlement would recover the land's role in recharging the aquifer (Nunes and da Silva 2016).

Under another Federal contract, 35% of the settlement's area must be protected as a Legal Reserve, restoring ecosystems through agroforestry in Áreas de Preservação Permanente (APP). At least 15% must be used for agroforestry without agrochemicals (Cassin and Nalli 2016, 362). Facilitating those contracts, a stronger Forest Code had established APPs to permanently conserve natural resources –such as water, biodiversity, flora, fauna, soil etc. – especially for human well-being. Likewise, the category Reserva Legal is a space requiring the owner to use natural resources in a sustainable way by conserving or restoring ecological processes (Brasil 2012).

Those agreements complemented the Assentamento's move towards an agroecological transition, especially through new agroforestry. Yet this faced several obstacles, namely: Although the settlement held collective tenure over the land, its division into family plots potentially undermined cooperation. Furthermore, some agroecological methods could perpetuate dependence on external experts. Without adequate on-site amenities and income, the settlers would depend on waged-labor in the nearby city, and the younger generation would leave, thus weakening any collective commitment. This general problem has risen in many MST settlements (Scopinho and de Melo 2017). Such obstacles could disorder the solidarity which had maintained the land occupation.

In order to move towards a socially cohesive future, the settlement promoted this vision: "Families cooperate and enjoy … generating a great abundance of food and water" (Cooperafloresta 2016a). To create such abundance, the Assentamento became a space for training, education and professional qualifications. The settlers sought and developed expertise to address several difficulties (agri-inputs, water scarcity, financial loans, etc.) to construct agroforestry as a socio-environmental agenda. Called nuclei, teams take responsibility in the organization of training for transversal tasks, e.g. health, water and security (interview, Mário Lago, September 05, 2017).

To strengthen the settlement's capacities, in 2015 some members set up Projeto Renascer das Águas do Aquífero Guarani. It had many working groups, e.g. Cultivation and Production, Administrative-Finance, Promotion, Commercialization, etc. Thus capacity-building was inserted into the members' general discussions and daily activities (Co-Labora Incubadora 2015, 43).

The project was hosted by the Universidade de São Paulo, Extensão Universitária, within its program funded by the Secretaria Nacional de Economia Solidária (SENAES). This program sought to "develop a culture influenced by EcoSol principles, values and practices, e.g. group autonomy, self-management and horizontal democratic management." It organized discussions and offered services on many themes, especially collective strategies for commercializing food products, obtaining public and private funds to finance activities through micro-credit, and group organization processes (Co-Labora Incubadora 2015, 21).

In such ways, the Mário Lago's cooperative structure built the internal capacities necessary to obtain and use state support measures, e.g the Plano de Desenvolvimento Sustentável (PDS), school food procurement and technical assistance (Nupedor 2016). From the start, the MST's regional staff had expertise to write grant proposals for development and knowledge-exchange; these skills were later extended. Work teams rotate across the various tasks: cultivation, food boxes, prices, transport, even security, thus building a horizontal organization and capacities among members (interview, September 4, 2017). The diverse agri-production helps to fulfill most of the settlers' food needs.

4.2. Strengthening circuitos curtos, income and social cohesion

The Assentamento's cooperatives have obtained organic certification through an Organização de Controle Social (OCS; MAPA 2008). On that basis, they gained premium prices through public procurement under the PAA and PNAE. Families initially depended on these programs for a stable income, as well as for dignity as food producers, thus countering the negative public image of *sem terras*. However, the PNAE's bureaucratic requirements dominated the agenda of assembly meetings, which were consequently attended by only 10% of cooperative members (de Melo and Scopinho 2015). Institutional sales readily became "iron cages," as in many other agroecological initiatives (Schmitt et al. 2017b).

Going beyond those limitations, in 2016–2017 Mário Lago's cooperatives initiated a subscription scheme for weekly food boxes, Cestas Agroflorestais, as a form of Community-Supported Agriculture (CSA). The weekly boxes are also sold in fairs, shopping centers and numerous stalls nearer the center of Ribeirão Preto (Figure 1). Direct sales have offered greater opportunities for the producers to build collective capacities, democratic self-organization, political support from civil society groups and economic independence from waged labor (de Freitas 2018), thus gaining economic power through their solidarity relationships. Work teams decide collectively on the contents, prices and commercial strategies; this deliberation process draws a humorous analogy with *pregão*, i.e. trading-floor deals (Figure 2). Half the cooperative members are women (de Melo and Scopinho 2015, 128).

To shape the MST's culture, its mass base initially came from descendents of southern European immigrants and later encompassed quilombos, who popularized their traditional jongo and later took up rap (de Souza and Bastos 2016). These composite cultures have contributed to the social cohesion of MST settlements. Many cultural activities have opportunities for youth to interact, sing and dance, often with guest performers (interview, September 4, 2017). For example, the MST's state-wide youth leader runs a rap group, whose films depict the MST's long struggle for land (Veneno H2 2013). In this way, the MST's musical culture has become inter-generational and inter-ethnic.

Figure 1. Lorry for delivering weekly food baskets (*cestas semanais*). Credit: Les Levidow.

Figure 2. Supply-chain stages of collective decision-making. Credit: Assentamento Mário Lago. Source: http://revistagloborural.globo.com/Noticias/Agricultura/noticia/2017/05/mst-produz-cestas-agroecologicas-que-incentivam-pequenos-produtores-assentados.html.

Together those efforts have transformed the settlers' lives, stabilized their commitments and attracted youth to remain:

> When the settlement was consolidated [2008], the family plots had nothing. People had to work in the city to put food on the table. Today they know agroforestry systems. They earn all their income from their plots. Agroforestry is our main tool for this social transformation … The settlers' children have an informal cooperative for managing all the activities including our production and commercialisation in the city. (Interview, September 4, 2017)

The Assentamento has been negotiating with the Education Ministry to establish an on-site school for several aims: to keep families there, to bring children of nearby families and to overcome negative stereotypes of *Sem Terras* (Cassin and Nalli 2016, 366). The settlement has been setting up an on-site kindergarten (MST 2019; Figure 3). All these activities have helped to build social cohesion, economic and political power to use public policies.

Figure 3. Nursery school. Credit: Assentamento Mário Lago. Source: https://www.facebook.com/agroflorestamariolago/photos/a.1927205377600383/2431067180547531.

4.3. Extending agroforestry through socio-environmental technologies

After abandoning agro-industrial methods, the settlement adapted Sistemas Agroflorestais Agroecológicos (SAFAs). The extra term *agroecológicos* denotes the systematic knowledge-exchange networks building the wider agroecology movement rather than a niche market. By extending SAFAs, reforestation serves to produce healthy food, provide income and recover the land, thus fulfilling the state-contractual commitment to replenish the aquifer.

The Assentamento's training program has incorporated scientific knowledge from various external experts. As a general strategy, the MST has been relying on the knowledge of settler-technicians who have been trained there (interview, Mário Lago, September 5, 2017). This arrangement helps avoid disagreements with external technicians and advisors (Nupedor 2016, 55).

"Socio-environmental technologies" describe the Assentamento's continuous innovation and improvement in techniques supported by the Projeto Cooperaflorestar, initially SAFAs (2016b, 19). Its capacity-building pillars include: participatory planning, cultivation, monitoring evaluation and training (Nunes and da Silva 2016, 46). Given the high cost of drip irrigation technology, the Assentamento designs systems with plants which can better adapt to drought and provide higher productivity (Nunes and da Silva 2016, 51). Socio-environmental technologies encompass capture, storage and treatment of water (interview, Mário Lago, September 5, 2017).

While the MST has regarded each settlement as a school for political struggle, Assentamento Mário Lago has extended this role to technical training and qualifications (Cassin and Nalli 2016). It seeks to "spread agroecology and agroforestry systems in other settlements in the state" (interview, Mário Lago, September 5, 2017). As a key means, Projeto Agroflorestar shares knowledge for "a regenerative agriculture which promotes food sovereignty" (Basso 2016). This has been sponsored by the Programa Petrobras Socioambiental of the state oil company, under its statutory mandate to fund socio-environmental projects. In all these ways, the settlement made special efforts to gain collective capacities for solidarity circuitos curtos, to gain grants for strengthening those capacities and to spread similar practices throughout the region.

5. Fórum de Comunidades Tradicionais (FCT)

For a long time the Costa Verde area had been urbanized, especially by civil construction projects for second homes or tourism. Meanwhile traditional communities' lands overlapped with *Unidades de Conservação* (conservation areas), some meant for public access. Government policy has often excluded traditional groups and privatized the management, based on the prevalent "myth of untouched Nature" (Diegues 1993). Such encroachments jeopardize traditional ways of life (Ferreira and Carneiro 2005).

According to government policy on traditional communities, a strategic vision should reconcile the aims to promote economic growth, to overcome social inequalities and to conserve natural resources (MMA n.d.). Yet government support has favored predatory forms of economic growth. Their territories "have been threatened by exclusionary environmental policies, real estate speculation, disorderly tourism, big infrastructure projects, urbanisation, climate climate, among other vectors" (Freitas 2017, 316). A predatory

tourism has sought to maximize profit through a disorderly use of the territory (Gallo and do Nascimento 2019, 62, 152).

Responding to the threats, in 2006 the Fórum de Comunidades Tradicionais (FCT) brought together three communities: indigenous Guarani quilombolas and caiçaras. Quilombolas are named after the quilombo forest refuges where escaped slaves had established free settlements. The term *caiçaras,* originally the Tupi Guarani word for tree branches, later named coastal residents engaged in farming or fishing.

Demanding *justiça socioambiental* (socio-environmental justice), the FCT seeks to maintain, protect and regenerate their territory. In 2014 the FCT launched a campaign, To Conserve is to Resist: "Preservar é Resistir: em defesa dos territórios tradicionais" (Figure 4). This has given a greater public visibility to their way of life and its conflicts with the prevalent development model. "Saber usar é a arte das comunidades tradicionais": Knowing how to use (natural resources) is the art of traditional communities. The concept *Bem Viver* has acquired specific meanings, for example: "a simple life, closer to nature, in a small town beyond urban velocity and with more solidaristic relationships, with a practical and theoretical enactment of the territory which promotes Bem Viver … " (Gallo and do Nascimento 2019, 294).

The FCT strategy has promoted community-based forms of nature conservation, agroforestry and political defense of their territory (Nonada 2017). Building on the area's traditional agroforestry, the FCT initiated Sistemas Agroflorestais (SAFs) seeking to link environmental conservation with their ways of life, which has been partly dependent on officially protected areas. The FCT has further developed agroforestry systems inside the coastal forest, extending their traditions in dialogue with new forms of knowledge.

Their agroforestry products have been commercialized collectively, e.g. through school food procurement (PAA and PNAE), public fairs and regional markets. In 2014 the Associação dos Produtores Orgânicos de Paraty (APOP) formed the Organização de Controle Social (OCS) for a Sistema Participativo de Garantia (SPG) to qualify for organic certification, thus gaining higher prices. The Paraty municipality gave significant support, especially to deal with administrative burdens (Strauch 2015, 164).

The FCT has linked traditional forests, food production and eco-tourism. These initiatives have been facilitated by a partnership between the FCT and Fundação Oswaldo Cruz (FioCruz), which funds the Observatório de Territórios Sustentáveis e Saudáveis da Bocaina (OTSS). The Productive Inclusion program improves ways

Figure 4. Fórum de Comunidades Tradicionais (FCT) logo. Credit: same.

Figure 5. Turismo de Base Comunitária (TBC). Credit: Fórum de Comunidades Tradicionais.

to conserve and use biodiversity. In the framework of the Federal Planapo for agroecological production, the Incubadora de Tecnologia Social (ITS) promotes production-consumption chains valorizing agro-biodiversity as products of socio-biodiversity, alongside youth participation and more equal gender relations (Gallo and do Nascimento 2019, 62, 152).

The FCT has opposed the mass tourism which was causing environmental pollution and incentivized land sales. A broad opposition network counterposed "a tourism based on communitarian management and valorisation of local knowledge" (de Miranda Mendonça, Albertino de Moraes, and Lima da Costa 2016, 241). The three communities have jointly designed Turismo de Base Comunitária (TBC, Figure 5), i.e. community-based tourism. This has been expanding short supply chains for a solidarity economy through various means, e.g. travel guides, restaurant Quilombo do Campinho and festivals with story-telling and music. Income is shared equally by all members of each work team (de Miranda Mendonça, Albertino de Moraes, and Lima da Costa 2016, 244). TBC also showcases the communities' roles in forest conservation. Together these activities provide "a self-recognition of our culture and traditions, which we had been losing and are now recovering for the community," said a coordinator (Marcondes 2018).

5.1. Creating a juçara culture

In such recovery, there has been a long-term effort to valorize and save the juçara tree. In the 1970s–1980s the trees were being illegally cut down for the palm hearts (palmitos), which are especially tasty and so easy to sell. The tree nearly became extinct and was officially listed as such. Nearly 70% of the forest fauna depends on the juçara tree, so its extraction destroyed even more biodiversity. From a socio-environmental perspective, the collective strategy has been to generate income from the juçara fruit as an incentive for restoring and conserving the trees (interview, FCT, September 7, 2017). The fruit is rich in healthy anti-toxins and anti-carcinogens, offering a large potential for products (Embrapa 2012).

As a significant advance for this strategy, during 2007–2010 the Environment Ministry funded a youth project linking local teams in five quilombo communities. They gained training in agroecology, sustainable development, community management, seed conservation and technical skills for repopulating the juçara tree (Strauch 2015, 109–110).

However, commercialization faced a big obstacle: under Forest Conservation law, any harvest belongs to state agencies. So the FCT made strong efforts to gain permission for a commercial scheme (interview, FCT, September 7, 2017).

As the next step, Projeto Juçara established a more ambitious self-organization of traditional communities for a solidarity economy (Figure 6). It has been establishing short supply chains in three phases: producing primary materials (raw products), converting them into products, and then commercializing them. Projeto Juçara has aimed to become financially self-sustaining in several ways: selling the fruit pulp in shops and export markets; generating income for owners of protected forests; and likewise for businesses that process the pulp into food products.

Juçara cultivation has become a basis for a new popular drink, a diverse gastronomy, Community-Based Tourism and regular festivals. These have been organized by caiçara as well as quilombo communities, both featuring their musical traditions (Ubatuba 2019). Thus the Juçara's recovery has helped to build an inter-community territorial identity (interview, FCT, September 7, 2017).

To develop such novel agroforestry-food systems, the FCT has promoted a dialogue between traditional knowledge and new knowledge from NGOs, universities and scientists. This is called *trocas de saberes* = knowledge exchange. Capacity-building is supported by state programs and the OTSS. The quilombo community has hosted visits from the state agency Embrapa Meio Ambiente (environment program). Its "technological caravan for family agriculture" advised producers on converting their artisanal methods into professional ones for large-scale pulp processing and year-round marketing (Embraba 2017). In a coastal area which had become a notorious sewer, the Praia do Sono, the FCT has adapted permaculture methods as a socio-environmental technology for ecological clean-up (OTSS 2018).

From those activities the FCT's Projeto Juçara won a 2016 competition for social technologies. An action-research approach enhances the societal benefits: "With a socio-environmental perspective, we are an incubator of social technology, which we are implementing on a larger scale" (interview, FCT, September 7, 2017; also Gallo and do Nascimento 2019, 149–171).

Figure 6. Projeto Juçara. Credit: Fórum de Comunidades Tradicionais.

5.2. Strengthening collective capacities, defending their space from threats

To strengthen collective capacities, a major opportunity came from Projeto Povos, funded by IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis), which promotes a shared management of forest resources for sustainable development. IBAMA's rules require the participation of traditional communities, that choose which of several themes and aims to pursue. These have included knowledge-exchange in the areas of agroecology, ecological clean-up and Turismo de Base Comunitária (OTSS 2019a).

To lead towards a more shared management, the OTSS has strengthened capacity building. Thematic nuclei have brought together representatives of the three communities with academic researchers. This novel arrangement seeks to promote more autonomous, effective actions; the training also seeks to achieve gender and ethnic parity of representation in management roles (Gallo and do Nascimento 2019, 80, 103). To spread knowledge more widely for a solidarity economy, advocates seek "to make this technological transition from a hegemonic production of capital towards a more cooperative mode, starting from a strong base in traditional practices in this territory and other experiences in Brasil" (OTSS 2019b).

In recent years the dominant development model has become a greater threat. "It has been transforming territorial relationships and affecting everyday life of our communities through environmental and social impacts" (Gallo and do Nascimento 2019, 14).

> A great transformation has been threatening traditional communities; Brasil has been undergoing a great setback … We regularly discuss what we can do together for a survival strategy. (Interview, FCT, 07.09.2017).

This echoes the classic critique of capitalist market-driven dispossession (Polanyi 1944).

Recurrent proposals have sought to change the ecological zoning of the Litoral Norte, permitting new construction by real-estate companies. Under a proposed constitutional amendment, moreover, such zoning decisions would be transferred from state bodies to the Federal Congress, that are relatively more favorable to real-estate interests. In response to this dual threat, the FCT demanded a guarantee that no change would jeopardize their ways of life. To gain wider support, it organized protests and spoke at public hearings (Nonada 2017; see Figure 7).

Given various threats potentially disordering their communities, the FCT has built collective capacities to defend their space from commercial interests. These activities strengthen common means of conserving and using natural resources to raise their livelihoods through a solidarity economy based on a multi-actor shared management. Agroforestry provides a focus for cross-community initiatives to build agri-biodiversity complementing ethno-cultural diversity, towards *justiça socioambiental*. The FCT's agenda seeks to transform the mode of production towards more solidarity, equitable relationships (Gallo and Setti 2012, 1434).

6. Conclusions

Let us return to the original questions at the start. How does agroecological innovation devise alternatives to the dominant modernization model? How do such alternatives depend on specific contexts, means and capacities?

Figure 7. Guarani protest against rezoning proposals, especially a constitutional amendment shifting decisions to the Federal government. Credit: Fórum de Comunidades Tradicionais.

The Green Revolution has exemplified the capital-intensive modernization model, provoking mass opposition from small-scale producers and civil society groups. They have jointly elaborated an agroecology-based solidarity economy agenda to contest the dominant agro-food system, especially in Latin America. Yet such efforts still encounter dominant models –e.g. innovation as technology diffusion or transfer, specialist management skills, markets as competition, nature as raw materials for inputs, etc. Beyond the Green Revolution per se, these features pervade society and limit alternatives.

Small-scale producers and civil society groups have experienced the dominant model as an obstacle, even as a threat. They have jointly elaborated agroecological innovation for a transformative role prefiguring alternative futures. Their efforts have mobilized and strengthened collective capacities of self-management for building solidarity *circuitos curtos*, broader support networks and interfaces with public policies.

Those efforts have been illuminated here through STS co-production theory. Its literature has generally focused on contentious technoscientific innovations, which may be experienced as threats of disorder. Adapting the theory, this paper has analyzed the wider modernization model of techno-diffusionist practices versus alternatives linking agroecological innovation with solidarity relationships. For those rival models, the analysis firstly identified the three main elements being co-produced through instruments of co-production (see again Table 1). Then, for the wider alternative agenda, our case studies demonstrated more specific forms; each constructs a socionatural order by co-producing nature, technoscientific knowledge and social order (Table 2).

The two cases illustrate differences in social origins, socio-economic contexts, threats from the dominant model, new opportunities and collective capacities to realize them. Having gained land tenure, Assentamento Mário Lago faced several more obstacles to fulfill its vision of socially equitable, solidarity relationships; it found solutions through cooperatives building Community-Supported Agriculture, settlement amenities and a composite musical culture. In a quite different context, the Fórum de Comunidades Tradicionais (FCT) brought together three societal groups facing exclusionary threats (e.g. from Conservation Areas and a real-estate

expansion), as well as from an individualist extraction of forest resources; the FCT promoted an inter-community cooperative identity by extending agroforestry traditions, building a juçara gastronomy and devising Community-Based Tourism.

Alongside such differences, the cases have these common features, in contrast with the dominant modernization model:

- *diálogo de saberes* among agri-producers and with external experts, rather than techno-diffusion by the latter;
- organic certification through Participatory Guarantee Systems which build knowledge-exchange to improve the agroecological methods;
- socio-environmental technologies devised by practitioners with advice from external experts, rather than perpetuating dependence on them, thus democratically redesigning techniques (Dagnino, Brandão, and Novaes 2004; Feenberg 2002);
- agro-biodiversity complementing socio-cultural diversity (Leff 2001), rather than a nature/society binary whereby resource extraction provides input-substitutes for agrochemicals;
- solidarity relationships facilitating more equal participation (across social origins, ages and genders), while extending traditions of mutual aid (*mutirão)*;
- composite cultures deepening the social basis of belonging (Zaoual 2010);
- short food-supply chains (circuitos curtos) building consumer support for dignified work and environmentally sustainable methods, rather than conventional market competition;
- collective capacities being built for self-management (or multi-actor shared management), thus avoiding dependence on specialist managers.

These cases illustrate variations on a broader EcoSol-agroecology agenda contesting the agri-modernization model. They do so through resistance, alternatives, capacity-building for them and the means to spread such capacities. For agroecological innovation as an alternative development model, each initiative seeks to transform its participants' lives and wider agri-food systems. Through STS co-production theory, this dual case study has shown how an alternative agenda emerges in context-specific forms.

Questions for further research: Given those diverse forms of EcoSol-agroecology, how do they strengthen, replicate and extend the wider agenda? How does the diversity contribute to composite forms of belonging? The post-PT Brazilian regime has been weakening earlier support measures, and Covid-19 restrictions have been disrupting *circuitos curtos*, together jeopardizing the EcoSol-agroecology agenda. So, how have its networks sought to turn this disorder into a just socionatural order?

Glossary of Brazilian names

Áreas de Preservação Permanente	Areas of Permanent Conservation
Embrapa Meio Ambiente	Environment unit of the Brazilian Agricultural Research Corporation
Movimento dos Trabalhadores Rurais Sem Terra (MST)	Movement of Rural Landless Workers
Organização de Controle Social (OCS)	Social Control Organization for participatory organic certification
Partido dos Trabalhadores (PT)	Workers' Party
Plano de Desenvolvimento Sustentável (PDS)	Sustainable Development Plan
Política Nacional de Segurança Alimentar e Nutricional	National Food Security Policy
Programa de Aquisição de Alimento (PAA)	Food Procurement Program
Programa Nacional de Alimentação Escolar (PNAE)	National Program of School Food Catering
Programa Nacional de Assistência Técnica e Extensão Rural (PNATER)	National Program of Technical Assistance and Rural Extension
Sistemas Agroflorestais Agroecológicos (SAFAs)	Agroecological Agroforestry Systems
Sistema Participativo de Garantia (SPG)	Participatory Guarantee System

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